Earthquake induced soft sediment deformation (seismites): new data from the Early Triassic Guryul Ravine section (Kashmir)

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Abstract: At the classical Guryul ravine section of Kashmir, the Permo-Triassic (P-T) boundary is located about 3 m above the base of the Khunamuh Formation. Brookfield et al. (2013) proposed that the deposits straddling the boundary between the Khunamuh Formation and the underlying, Permian Zewan Formation are Siberian Traps-induced seismites overlain by tsunamites. These deposits have been subject to a divergent re-interpretation by Krystyn et al. (2014), who rejected a Siberian-Traps origin. Here, we report the discovery of highly contorted beds at the top of a 7 m. thick, thin-bedded, light beige nodular lime mudstone, a new lithological unit recorded in the Early Triassic Khunamuh Formation, 120 m above the top of the Zewan Formation. These contorted beds, about 1 m thick, are showing typical earthquake induced soft sediment deformations, similar to the latest Permian in the lower part of the section. This new nodular limestone is of early Spathian age as indicated by our conodont sampling and crops out at the base of a cliff-forming limestone interval named Niti Limestone throughout the Tethys Himalaya area since the 19th century. It is interesting to note that both latest Permian and early Spathian seismites occur at a marked lithological change, i.e. a shift in the depositional settings. The latest Permian seismite occurs on a delta ramp with mixed quartzose sand, silt and shelly carbonate lenses, storm influenced deposits, followed by an abrupt contact with the overlying deeper, thin- bedded and siliceous clay mud turbidite deposits and rare lime mud lenses. The early Spathian one is intercalated at the top of a distal ramp nodular limestone deposits, just at the change to the shallower thick-bedded Niti limestone. The latest Permian seismic activity coincides with a platform drowning during a transgressive phase and the early Spathian one occurred during a platform uplift, also during a transgressive phase. Both may conceivably have been driven by recurrent phases of syn-sedimentary block faulting of the northern Indian passive margin. In this, we agree with the conclusions of Krystyn et al. (2014) that any relation between the local occurrences of seismites-tsunamites and the eruption of the Siberian traps is unlikely. Yet, we must keep in mind that both coincide also with global shifts in the geochemical, sedimentological, paleontological and climate records.

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Earthquake induced soft sediment deformation (seismites): new data from the Early Triassic Guryul Ravine section (Kashmir)

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Introduction

At the Guryul Ravine section in Kashmir, we report a new lithological unit in the Early Triassic Khunamuh Formation, 120m above the top of the Zewan formation. The beds show typical earthquake induced soft sediment deformations, similar to latest Permian structures present in the lower part of the section (120m below).

Both latest Permian and early Spathian seismites occur at a marked lithological change, visible in the sedimentary deposition.

The seismic activity from the latest Permian coincides with a platform drowning during a transgressive phase. The early Spathian one occured during a platform uplift, also during a transgressive phase.

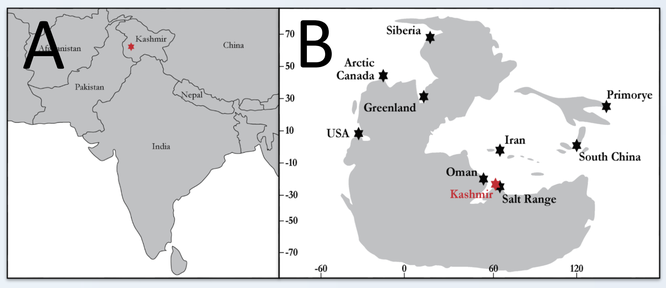

Figure 2A; Location of Guryul Ravine, Kashmir, India. 2B; Early Triassic (250 Ma) paleogeographic map.

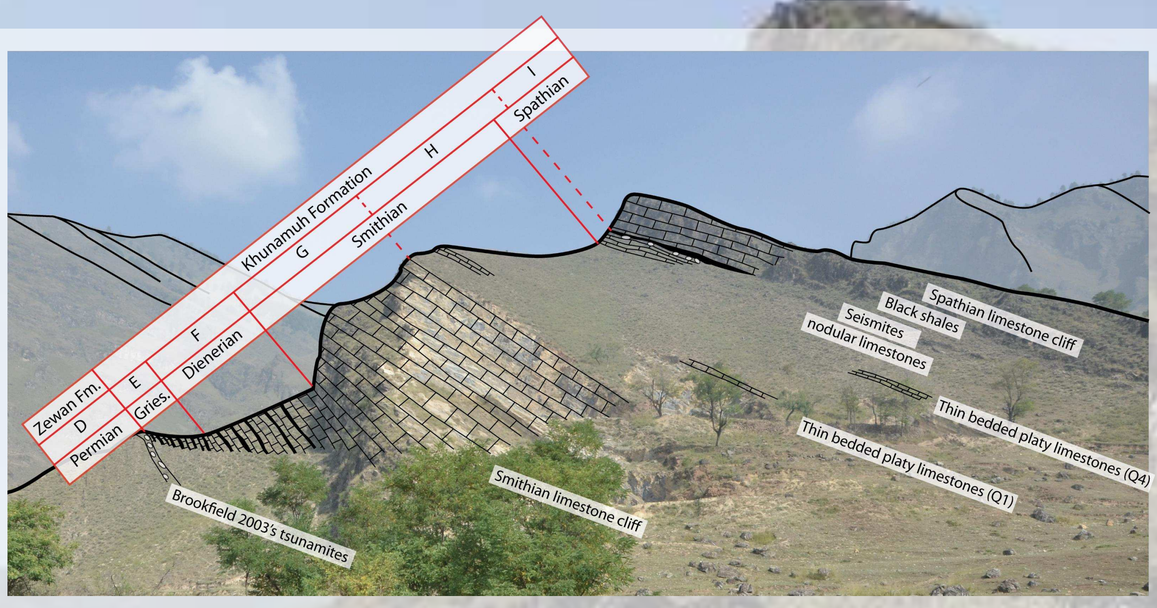

Figure 1; Guryul Ravine section with geological units (D to I) belonging to the Zewan and Khunamuh Formation. It is a continous section from the late Permain to the middle Triassic.

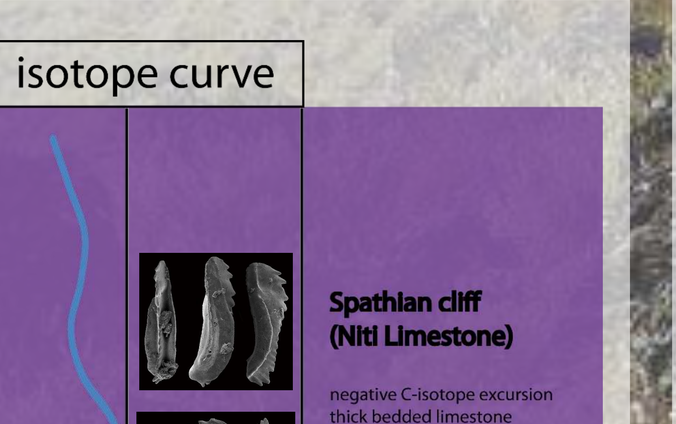

Figure 3; Early Spathian part of the Khunamuh Formation from Guryul Ravine with the nodular Limestone, the seismitic beds (orange colored) and the Spathian cliff.

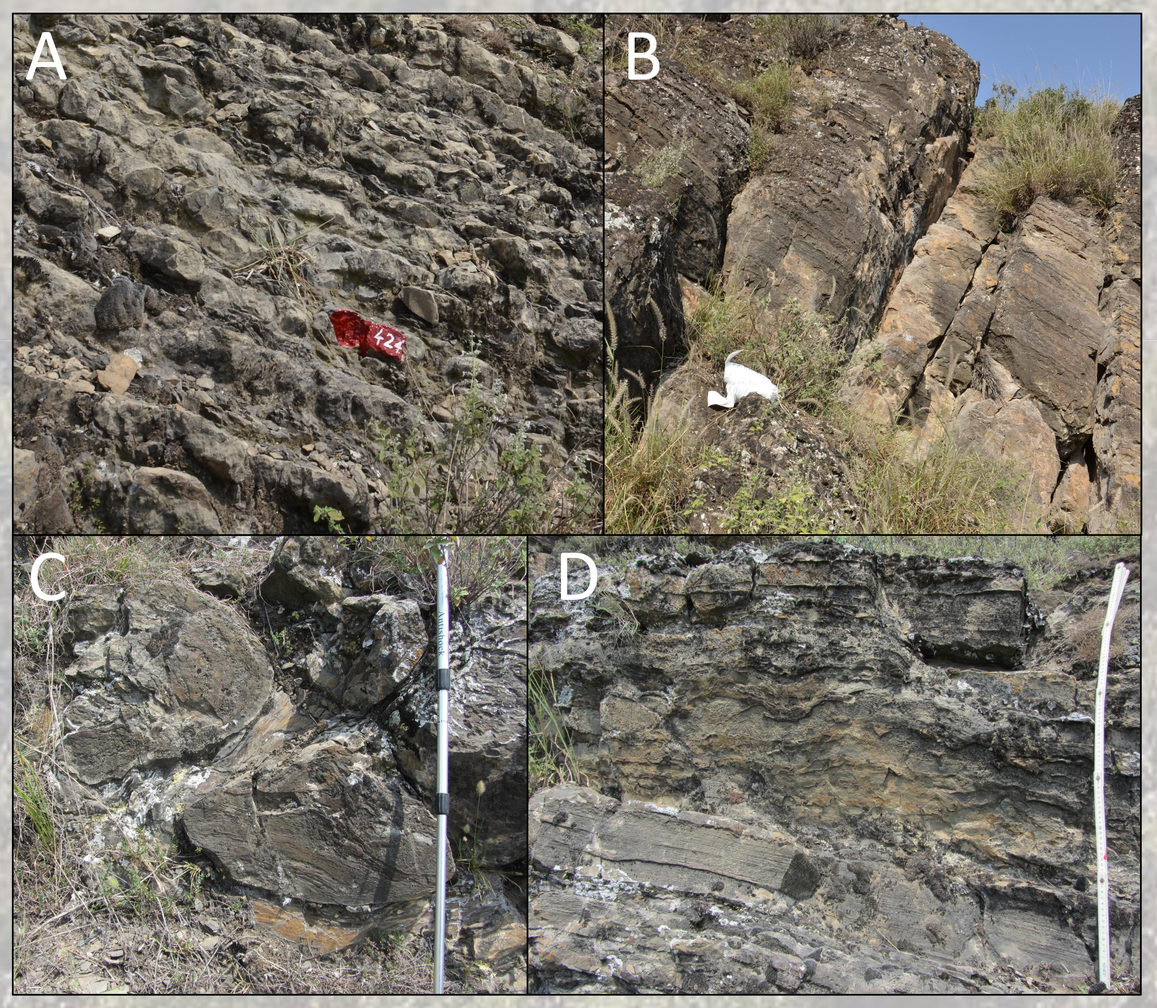

Figure 4: Spathian seismite; A: nodular limestone (7m), at the base of seismites unit, early Spathian. B: Spathian cliff (Niti Limestone), at the top of seismites unit. C and D: soft sediment deformation structures at the top of the nodular limestone, base of Spathian cliff. Contorted beds (1m thick) similar to the latest Permian unit.

Figure 6; Lithological log and inorganic carbon isotope curve. A giant positive peak of $\delta^{13}C_{(carb.)}$ occur at the Smithian-Spathian boundary and during facies changes. Conodonts are shown at the corresponding zones as index fossils.

Figure 5: Latest Permian seismite; A: Bed 46/2 with large pillows and pseudonodules (description in Brookfield et al., 2013), scale 1m; B: Guryul Ravine section around the PTB (red line) with the seismitic bed at the top of the Zewan formation.

Conclusion

Seismites are found in the late Permian and the early Spathian. The seismic activity may conceivably have been driven by recurrent phases of syn-sedimentary block faulting of the northern Indian passive margin. In this, we agree with the conclusions of Krystyn et al. (2014) that any relation between the local occurrences of seismites-tsunamites and the eruption of the Siberian traps, as hypothesized by Brookfield et al. (2013), is unlikely. Yet, we must keep in mind that both coincide also with global shifts in the geochemical, sedimentological, paleontological and climate records.

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